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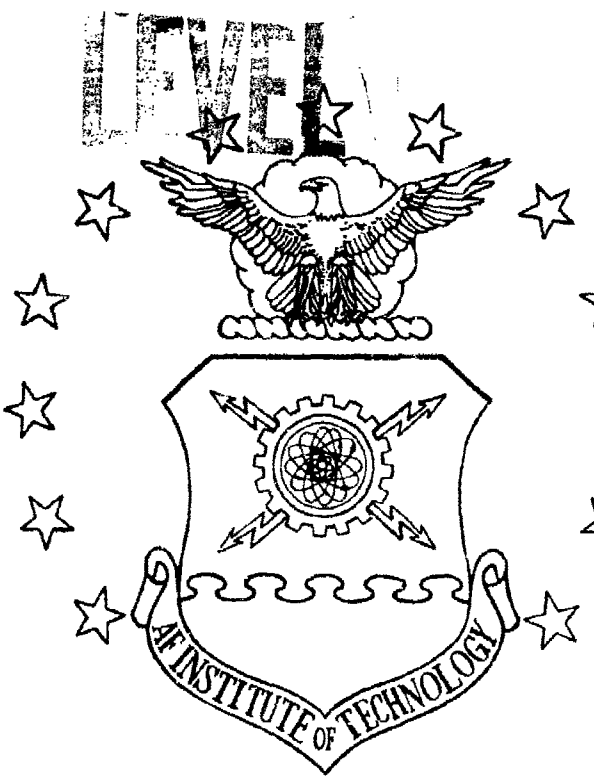


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# ANALYSIS AND COMPUTATION OF A BASE LABOR RATE FOR COST MODELS OF MAJOR WEAPON SYSTEM ACQUISITION.

Dale E./Knuth, Major, USAF
Robert F./Unger, Captain, USAF

LSSR-21-78A

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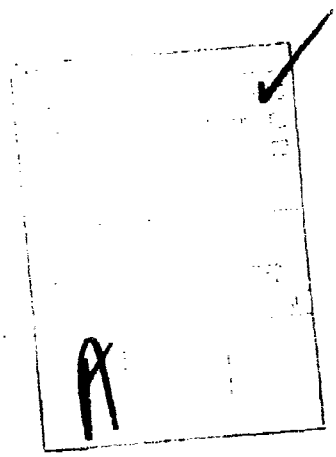

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The purpose of this thesis was to analyze and compare the Base Labor Rates determined by the full cost approach versus the Maintenance Cost System. If the labor rates were determined to closely approximate each other, then the MCS would be an efficient way to obtain a base level maintenance labor rate. Two bases in the Southeastern United States which support transport aircraft were studied. The elements of cost which make up the Depot Labor Rate were used to facilitate the full cost of the Base Labor Rate. The elements of cost were subdivided into three categories--direct labor, indirect labor, and overhead. The summation of these elements were divided by the manhours available to determine a labor rate. This rate was compared to the rate derived from the MCS. The rates were comparable at one base, but not at the other. The results were incorclusive and further study was recommended.

LSSR 21-78A

# ANALYSIS AND COMPUTATION OF A BASE LABOR RATE FOR COST MODELS OF MAJOR WEAPON SYSTEM ACQUISITION

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

By

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has been accepted by the undersigned on behalf of the faculty of the School of Systems and Logistics in partial fulfillment of the requirements for the degree of

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TABLE OF CONIENTS

LIST OF TABLES

LIST OF FIGURES

# Chapter 1

# INTRODUCTION

## OVERVIEW

The cost of operation and support of weapon system ownership has increased tremendously in recent years. Department of Defense (DoD) managers are seeking new ways to reduce these costs. The use of cost estimating models is one of the means by which DoD managers are attempting to find least cost alternative ways of doing business (8:3). However, the cost estimating models are not without problems. This research deals with one such problem.

## PROBLEM STATEMENT

The use of models as a tool in estimating costs in weapon system acquisition and follow-on support has greatly increased in recent years due to the increased cost of weapon system ownership. A majority of weapon system ownership costs are the Operation and Support (O&S) costs (2:1-3). Some cost models are used for computing total life cycle costs of weapon systems while others are used for computing estimates of expected support costs which might be incurred by adopting a particular design or choosing a certain design alternative. The latter type does not

compute an absolute value of support cost, but rather the magnitude of the cost difference between two alternatives (10:4).

There are many data elements (variables) which are used in the mathematical computation of cost models. Some of these data elements are furnished by the Government as standard elements (10:1-8). The accuracy of one major data element, Base Labor Rate, has been questioned by one of the prime contractors of the Advanced Medium STOL[1] Transport (AMST). Therefore, there is an existing need to determine an accurate Base Labor Rate (BLR) for major weapon system acquisition cost computations (9).

## JUSTIFICATION

The Advanced Medium STOL Transport (AMST) System Program Office (SPO) has requested a critical evaluation of the Base Labor Rate (BLR), which is a major input variable of their Cost Analysis Cost Estimating (CACE) model (9). The AMST SPO was questioned by one of the prime contractors as to the validity of the BLR because the rate was considerably different from the labor rate used in the commercial aircraft industry. Since the BLR is an Air Force Standard Information value, the Air Force is responsible

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[1]STOL stands for short take-off and landing.

for its accuracy. Specifically, the Deputy Program Manager for Logistics is responsible for the BLR used in the Logistics Support Cost (LSC) model (10:7). Further investigation disclosed that the BLR used in the CACE model is the same BLR used in the Logistics Support Cost (LSC) model developed by Air Force Logistics Command (AFLC) (9).

A personal interview with Mr. Steve Klipfel (7) in the AFLC Cost Analysis Division brought out the procedure which was used to determine the present BLR for the LSC model. In 1974, AFLC/ACM requested Maintenance Cost Data from all operational flying units in the Air Force. However, only two units responded with information about their maintenance costs. The specific information provided by the two wings, and used by AFLC to calculate the maintenance cost, was the Responsibility Center/Cost Center by Element of Expense/Investment Code, Cost Center Performance Summary, and the Monthly Maintenance Data Analysis Report. The BLR was calculated by dividing total maintenance cost by the number of manhours attributed to direct labor. Since 1974, this figure has been updated only to reflect inflation (7).

In the original calculation, many indirect costs were not considered. For example, training costs were not used because the figures were not available (7). Also, consideration was not given to retirement costs, medical and dental care, and base support activities such as the

Base Exchange and Commissary. The fact that these costs were not considered led to the question of the validity or accuracy of the calculated BLR (9).

Mr. Klipfel stated that his office was very interested in obtaining an accurate BLR, but the lack of time and guidance had prevented further progress towards that goal. Further, he requested a copy of this thesis be made available to his office so the results can be studied and possibly incorporated into AFLC's Logistics Support Cost model.

The BLR becomes very important when the weapon system O&S costs are considered. For example, the decision to design an aircraft for a greater share of maintenance work at the base level and less at the depot level may depend in part upon the BLR used. A BLR originally calculated from two fighter wings, which was limited in scope and updated for inflation only, will not give an accurate BLR to be used in decisions regarding the acquisition of a transport aircraft (9).

Also, in the acquisition process where selection of a contractor is based upon the total expected cost of a weapon system, the BLR furnished by the Air Force plays a big part in estimating these costs (9). The costs affect the design considerations of the contractor in his attempt to lower the total cost of weapon system ownership. If the costs are subject to question, as in the cases of the

AMST and the LSC model, then further research may provide the means to achieve more accurate and consistent estimates. Although the AMST SPO initially requested research on the BLR used in the CACE model and later the Cost Analysis Division of AFLC expressed a desire for an accurate rate, the same BLR is also used in other cost models. Therefore, the research accomplished to determine an accurate BLR will not only benefit the AMST SPO and AFLC, but provide an accurate rate for all of the other cost models in the Air Force which utilize a BLR.

## BACKGROUND

In recent years, DoD managers have been encouraged to seek ways to minimize weapon system acquisition costs. Decreased buying power, constraints on appropriations by Congress, and increased operating and support costs have led to these new requirements (2:3). DoD managers first adopted the Design to Cost (DTC) concept to accomplish this goal. DTC is the management and control of future acquisition, operating, and support costs during the design and development process under established cost objectives. The concept of DTC was intended to consider all costs, but the Operation and Support (O&S) costs were given little visibility by DoD managers as an area of viable costs consideration (4:2). This lack of visibility led to the development of Life Cycle Cost (LCC), which placed emphasis upon

all costs of weapon system acquisition and stressed an optimum balance between the costs of development and production on the one hand and the outyear cost of fielding, supporting, and operating the system on the other (2:1; 3:2).

LCC is the total cost of acquiring the weapon system from the moment the acquisition is conceived until the weapon system is removed from the inventory. These costs include all costs associated with research and development, design, engineering, production, and all operating and support costs (8:1). However, Life Cycle Cost is not to be confused with Life Cycle Costing:

> Life Cycle Costing, in its purest sense, is the process of estimating Life Cycle Cost. That meaning, however, is rarely intended in practice. Cost estimating generally is performed to aid in decision-making; and a decision-maker rarely needs to concern himself with the entire life cycle or with all categories of cost. Hence Life Cycle Costing has come to mean the process of estimating all those costs or cost increments which can influence the decision at hand. ("Can influence" is arbitrarily used to mean "are relevant to, can be estimated with accuracy to be used in, and might affect the choice of"). In equipment procurement or system acquisition, therefore, Life Cycle Costing means estimating all those costs which can affect the choice among competing designs, among operations, among possible procurement procedures, or among competing proposals for production [8:1].

The O&S costs are a less visible category of operational costs which continues to recur throughout the life of the system (6:2). O&S costs include direct and marginal cost for personnel and material at the base level, depot

support cost, and personnel pipeline cost. The development of cost models is one of the approaches the Air Force has adopted to incorporate the Life Cycle Costing of O&S costs. The CACE and the LSC models are two of these models.

The CACE model provides a means for estimating the aircraft squadron annual operating costs while maintaining the flexibility to select relevant cost factors or adapt to changes in methodology of cost estimating (19:2-15). The model was designed to be used for cost or research analysis, life cycle cost exercises, or studies concerned with cost effectiveness comparisons between weapon systems. The CACE model is not to be used for Planning, Programming, and Budgeting (PPB) exercises. PPB cost estimating is to be done with the Planning, Programming, and Budgeting Annual Cost Estimating (BACE) model, which is very similar to the CACE model in estimating squadron annual operating cost, but doesn't have the flexibility in the selection of factors or changes as incorporated in the CACE model (19:2-14 to 2-15).

Variable inputs to the CACE model may be categorized into three areas: Air Force Standard Information, System Standard Information, and Design Sensitive Information (6:5). The input values of Air Force Standard Information include wage rates, cost of fuel per gallon, personnel turnover rate, and cost of training.

The LSC model is used to estimate the expected support cost that may be incurred by adopting a particular alternative. The model compares and contrasts among design alternatives where relative cost differences are of importance. The significance of the results is based on the magnitude of the cost differences between the two alternatives and not on the absolute value of the support costs. Although the LSC model is not, strictly speaking, a life cycle cost model, it is one of the many specialized models to support the technique known as life cycle costing (10:3-4). There are over 90 data elements which are utilized in the mathematical relationships in the model. These data elements can be classified into five categories. One of these categories is Government-Furnished Standard Elements. Some standard elements furnished by the Government are inventory costs, repair-cycle times, and labor rates (10:6-7).

The Air Force has Maintenance Data Systems and Personnel Data Systems from which information can be obtained to calculate a direct labor cost. Other costs, which are not contained in the budgets at base level, will not be considered in calculating the BLR. The USAF Cost and Planning Factors Regulation (AFR 173-10) or other sources will need to be utilized for these other costs. Examples of these other costs are initial training and acquisition.

## SCOPE

The data gathered for the research will be limited to transport type weapon systems. The two transport weapon systems on which data will be gathered are the C-141 and C-130. Data will be collected from two Air Force bases: one which supports the C-141 weapon system and another which supports the C-130 weapon system.

Existing information systems will provide all data on manpower and cost. It is beyond the objective and level of effort of this research to develop new information or data systems from which a BLR can be determined. The information already gathered for Fiscal Year 1977 will be used. This information will be analyzed and compiled to reflect the actual cost of maintenance at the squadron level. The squadron level was selected because both the CACE model and the LSC model estimate operating and support costs at that level.

## OBJECTIVES

The overall purpose of this research was to make a cost analysis of the full cost of performing aircraft maintenance at the base level. There are three primary objectives of the research. The first objective is to determine what input variables or elements of cost need to be considered in allocating all appropriate costs to BLR.

Second, an approach for obtaining and compiling the necessary relevant cost and manpower data from existing data systems will be developed. Third, the development of an equation from which a BLR can be derived and updated periodically as the input variables take on different values will be attempted.

## RESEARCH QUESTIONS

The following questions were used to guide the research towards its objectives:

1. What input variables are needed to capture all basic elements of the total cost of labor (direct, indirect, and overhead) in the BLR?

2. What information in existing Air Force data systems can provide values for the identified input variables?

3. What equation or set of equations can be developed to produce and revise a BLR?

# Chapter 2

# METHODOLOGY

## INTRODUCTION

The ultimate objective of this research is to develop an equation from which a monetary value reflecting the full cost (direct, indirect, and overhead) of base level aircraft maintenance may be determined. The values of the input data to this equation are limited to those values which are existing in current functioning data systems. In order to arrive at an accurate BLR, the following methodology will be used:

a) Determine the selection of input variables, or elements of cost, which are related as closely as possible to the elements of cost of the depot labor rate.

b) Determine the monetary value which should be allocated to each element of cost of the BLR.

c) Determine the full cost BLR by the summation of the applicable elements of cost which can be derived from existing data.

d) Compare the results of the monetary value determined by the evaluation of the full cost of maintenance at the base level to the monetary output of the

maintenance cost system described in Air Force Manual 177-380, USAF Standard Base Level Maintenance Cost System (B 3500).

## ELEMENTS OF COST

To gain a firmer idea of the different elements of cost needed to compile a BLR, the elements of cost for the Depot Labor Rates (DLR) were considered. The elements of cost for DLR are detailed in DoD Handbook 7220.29-H, "Depot Maintenance and Maintenance Support Cost Accounting and Production Reporting":

> The purpose of this Handbook is to set forth a set of principles, standards, policies, definitions and requirements for uniform cost accounting and reporting by all DoD Depot Maintenance activities. It also provides criteria for the identification and segregation of maintenance costs from maintenance support costs and accounting and reporting requirements for maintenance support activities [21:100-1].

The data from the Depot Level Cost Accounting System enables the depot managers to develop standard unit costs of depot maintenance work (21:110-1). The standard unit costs are costs used by the depot to charge for work performed. In other words, the depot labor rate. The elements of cost used to compile the depot unit cost will be the same elements of cost used to determine the cost of maintenance at the base level. The full cost of maintenance, at the base level, reduced to an hourly rate, will give a BLR which will be comparable to the Depot Labor

Rate. As a result, both labor rates will be comprised of the same elements of cost, thus enabling managers of the weapon system acquisition program to determine the alternative which will result in lower operation and support costs in the costing models.

Full Cost

In order to derive a BLR, the full cost of maintenance labor must be determined. The input variables, described by Anthony and Herzlinger as elements of cost, need to be identified and combined to produce a full cost (1:25).

> Program costs measure the full cost of a cost objective, . . . and its full cost is the total amount of resources that are inputs to that program. These inputs are the sums of direct costs plus an equitable share of indirect costs [1:25].

Program, full, and total costs are used by different authors to convey the same meaning. That is, the summation of every cost element expended in order to accomplish an objective is considered to be the full cost of accomplishing that objective. The full cost of performing maintenance labor at the base level is the summation of direct, indirect, and overhead cost. Figure 1 presents a graphic description of full cost.

| Full Cost | = | Direct Cost | + | Indirect Cost | + | Overhead Cost |
|---|---|---|---|---|---|---|

Figure 1

Full Cost Approach

Direct Cost

The direct costs identified in this research were those costs which could be identified to the end item upon which maintenance is performed (19:pp.2-11). "Items of direct cost are those directly traceable to a single cost objective, such as the salaries of persons who work directly for a given program [1:25]." The cost of wages and salaries of personnel who actually perform the maintenance labor are considered direct costs in this thesis.

The military uses skill levels as a part of a job specialty code to indicate the amount of training, experience, and expertise possessed by an individual. The higher the skill level, the more qualified the person. The higher skill levels tend to be supervisors. Since the data on maintenance personnel is given by skill level, the separation of working and supervisory personnel is done by assigning skill levels 5 (journeyman) and below (apprentice) as direct labor personnel and skill levels 7 and above as supervisory personnel. Consequently, all civilian maintenance personnel and military maintenance personnel with a skill level of 5 and below were considered as direct labor personnel.

The cost of direct labor was obtained from the Responsibility Center Managers Monthly Report and the Responsibility Center Cost Center Report. Both reports contain the same data, but the format is different. The

cost of enlisted supervisory personnel is subtracted from the total cost of enlisted personnel contained in the reports to obtain the cost of direct labor personnel. The cost of civilian direct labor added to the cost of military direct labor is the total cost of direct labor.

Indirect Cost

According to Anthony and Herzlinger, "Indirect costs are costs applicable to several cost objectives, one of which is the cost objective in question [1:22]." They further stated:

> Items of indirect cost are those that are common to several programs. Each of these programs is assigned to an equitable share of the total indirect cost, the amount being determined on some reasonable basis. If feasible, the amount assigned to each program is measured either in accordance with the relative benefits received by that program, or in accordance with the relative amount of cost caused by the program. If neither a beneficial or casual relationship exists, the item of cost is allocated in accordance with the overall size of the respective programs [1:25].

The DoD Handbook for Depot Maintenance describes indirect costs as those costs not charged to direct cost (21:pp.350-1). It further divides indirect cost into operations overhead and general and administrative overhead. The operations overhead consist of all the indirect cost incurred by the cost center plus the allocated share of indirect departments or service centers (21:pp.350-1). The General and Administrative overhead includes expenses incurred by the maintenance activity plus costs allocated by higher headquarters (21:pp.350-2).

This research considered indirect cost to be the cost of supervisory personnel plus an allocated share of base supporting costs. Supervisory personnel consisted of all officers plus enlisted personnel with skill level of 7 and above. The allocated share of base support is based upon the number of maintenance personnel assigned to a squadron as compared to the number of personnel assigned to the base. The indirect costs assessed against the squadron maintenance personnel, therefore, are expressed as a percentage of maintenance personnel divided by the total number of personnel on the base.

The monetary value of military personnel was obtained from the Responsibility Center Managers Monthly Report and the Responsibility Center Cost Center Report. The total cost of Base Support, Civil Engineering, and Medical Services obtained from the two reports was then multiplied by the percentage factor to determine the allocated share of indirect costs.

Overhead Cost

As previously stated, indirect cost is subdivided by the DoD Depot Maintenance Handbook into operations and general and administrative. The general and administrative costs are those incurred by the maintenance activity plus costs allocated to it by higher headquarters (21:pp.350-2). The cost of maintaining the maintenance activity plus the

cost of the chief of maintenance function were considered overhead cost. Monetary values for both of these costs were obtained from the Responsibility Center Manager Reports.

## MONETARY COST AND PERSONNEL DATA

The approach to determine the direct, indirect, and overhead costs at the base level used the Responsibility Center/Cost Center (RC/CC) and Element of Expense/ Investment Cost (EICC) data for two bases which support transport weapon systems. Charleston AFB, South Carolina and Pope AFB, North Carolina support the C-141 and C-130 weapon systems, respectively. The reports involved included the "Responsibility Center (RC) Manager Monthly Report," 30 September 1977; and the "RC Managers Cost Center Report," 30 September 1977.

Captain May (9) recommended Charleston AFB and Pope AFB as sample bases. The two bases support similar type weapon systems and missions while at the same time maintain the "clean" base environment. The use of "clean" is meant to minimize the effects of other weapon systems, missions, headquarters, etc., which could affect the computation of the labor rate.

The monetary value from the RC/CC Reports was subdivided into direct costs, indirect costs, and overhead. The direct costs are those costs directly related to the

"hands-on" maintenance of the weapon system. The indirect costs are those costs which cannot be related to the weapon system, but can be related to supporting the maintenance effort. Overhead costs are costs which can be related to the maintenance support of the weapon system, but do not include "hands-on" maintenance costs (20:pp.2-12 to 2-13).

The unit strength reports were provided by the Personnel System Manager Section of the respective Consolidated Base Personnel Offices. These reports contain the unit strength for each base and maintenance organization by month. The twelve months for FY 1977 were averaged to minimize seasonal fluctuations. The ratio of the number of maintenance personnel to the number of total base personnel is a factor which can be used to allocate the indirect costs. An example of an indirect cost is the cost of personnel services at the base. The total cost of providing personnel services was multiplied by the indirect cost factor and the result was the portion of personnel services costs which should be allocated to maintenance. The combination of direct labor costs plus the allocated proportion of indirect costs and the cost of overhead were totaled to obtain the BLR.

## FULL COST

The full costing approach was used in this research to determine the cost of aircraft maintenance at the base

level. The full cost of a program is "the sum of the direct cost plus an equitable share of indirect costs [1:25]." Anthony and Herzlinger further state that some nonprofit organizations, such as DoD, do not include all elements of full cost in their program costs. The example of excluding certain general and administrative costs was used (1:25).

> The omission of indirect expenses from program costs may hamper the work of planners, however, for planners usually need to know the full costs of programs, which include both the direct and indirect costs [1:122].

The full cost of aircraft maintenance labor compiled in this research included direct costs, indirect costs, and the cost of overhead. The sum of these costs represents the full cost of aircraft maintenance labor at the base level. Although a full costing approach was attempted, Anthony and Herzlinger stated such an approach is not without its problems.

> Full cost information may also facilitate the comparison of the cost of performing certain services in government with the costs of comparable services in private organizations, although the innate difficulties of making such comparisons should not be minimized [1:123].

Any applicable elements of cost which cannot be computed by utilizing the information obtained by the base level information systems will be identified in the Cost Analysis chapter of this thesis.

## COMPARISON OF THE MAINTENANCE COST SYSTEM AND THE COMPUTED BASE LABOR RATE

The USAF Standard Base Level Maintenance Cost System (B3500) provides monthly reports which are cost oriented; that is, they are measured by use and consumption of resources (20:pp.3-66). This system provides reports of Organizational and Intermediate Maintenance Costs at the base level. The reports have both military and civilian categories and are divided into direct labor, indirect labor, and overhead costs. Indirect labor includes supervision, training, detail, leave, compensatory time taken, alert, and miscellaneous. The overhead includes costs for general and administrative (military and civilian), TDY, rents, and contractual services (20:pp.366 to 3-73).

The sum of the direct, indirect, and overhead cost derived from the Organizational and Intermediate Maintenance Cost Report: Report-1A, will be divided by the number of hours expended. The number of hours expended by maintenance personnel is also contained in the same report. The hourly rate derived from the Organizational and Intermediate Maintenance Cost Reports will be compared to the hourly rate derived from the Responsibility Center Reports to see if the monetary values are approximately the same.

## SUMMARY LIST OF ASSUMPTIONS

The assumptions of this thesis are:

1. The elements of cost which determine the Depot Labor Rate are applicable to the BLR.

2. The elements of cost can be identified for each category of labor.

3. A monetary value may be assigned to each element of cost.

4. The Responsibility Center/Cost Center and each Element of Expense Investment Code at base level reflect true monetary values.

5. The personnel data systems reflect the true number of personnel located at each installation and in each work center.

6. The influence of other base organizations will not have an adverse effect upon the computations utilized in developing the BLR equation.

7. Maintenance Cost System reports are available at the bases used in the sample.

## SUMMARY LIST OF LIMITATIONS

The limitations of this research are:

1. The derivation of the BLR will be limited to transport aircraft. Any application of the equation to different type weapon systems will require modifications.

2. The monetary values reflected will be based on expenses experienced in FY 1977. Any future projection of the derived monetary values will require adjustment based on future cost variations.

# Chapter 3

# ELEMENTS OF COST

## OVERVIEW

This chapter identifies and defines each element of cost considered in determining the full cost of maintenance labor at the base level. The data and methodology used to develop a monetary value for each element of cost is presented and a labor rate based upon Fiscal Year 1977 (FY 1977) is determined. The elements of cost are subdivided into three major categories--Direct Labor Cost, Indirect Cost, and Overhead. Rationale for including each element of cost in the full cost is presented. If an element of cost is excluded from the full cost of maintenance labor, the rationale for its exclusion is presented. Each element of cost was evaluated to determine if it should be assigned as an element of full cost of maintenance labor. The full cost of maintenance was then determined. This amount divided by the number of maintenance labor hours available will determine the cost of base maintenance as an hourly rate.

## DEVELOPMENT OF PERCENTAGES

In order to prorate the associated costs of maintaining the Air Force base, percentage factors which represent a portion of the total cost to be allocated to the cost of maintenance were developed. The total number of personnel stationed on a particular base were extracted from the Average Strength Data Reports for the Fiscal Year (FY 77). These reports were averaged over the entire year to minimize seasonal fluctuations of manpower strength.

The Maintenance Digest Reports for each month of the FY 77 were examined to determine the number of personnel assigned to a maintenance squadron involved in direct maintenance labor. These numbers were averaged over the year to minimize seasonal fluctuations. The number of personnel assigned to skill levels of five and below were considered direct labor personnel. The number of personnel with skill level seven and above were considered supervisory personnel. Officers assigned to the squadrons were also assigned as supervisory personnel to facilitate their incorporation into the indirect cost category. Table 1 presents the number of personnel associated with each category and the percentage of personnel associated with direct labor versus the number of personnel assigned to Charleston AFB, South Carolina.

Table 1

Development of Percentage Factor for
Charleston AFB, South Carolina

1. Number of military personnel assigned to Charleston AFB, South Carolina during FY 77:[1]

| | Officer | Enlisted |
|---|---|---|
| October | 660 | 4288 |
| November | 645 | 4272 |
| December | 6 | 4216 |
| January | 66 | 4280 |
| February | 673 | 4277 |
| March | 665 | 4236 |
| April | 668 | 4258 |
| May | 677 | 4254 |
| June | 669 | 4140 |
| July | 664 | 4160 |
| August | 671 | 4282 |
| September | 654 | 4080 |

2. Average number of military personnel assigned during FY 77:

48?1

3. Number of personnel assigned to maintenance activities during FY 77 by squadron:[2]

| | OMS | | | FMS | | | AMS | | |
|---|---|---|---|---|---|---|---|---|---|
| | A* | B** | C*** | A* | B** | C*** | A* | B** | C*** |
| Oct | 88 | 467 | 21 | 99 | 477 | 173 | 55 | 175 | 55 |
| Nov | 93 | 453 | 21 | 96 | 470 | 173 | 57 | 173 | 53 |
| Dec | 90 | 441 | 21 | 96 | 463 | 173 | 56 | 178 | 52 |
| Jan | 97 | 430 | 21 | 96 | 455 | 171 | 58 | 177 | 52 |
| Feb | 94 | 429 | 21 | 94 | 453 | 170 | 62 | 171 | 51 |
| Mar | 93 | 426 | 21 | 94 | 457 | 173 | 61 | 170 | 51 |
| Apr | 91 | 434 | 21 | 93 | 468 | 173 | 60 | 173 | 52 |
| May | 93 | 439 | 21 | 92 | 461 | 174 | 57 | 171 | 52 |
| Jun | 89 | 446 | 21 | 93 | 455 | 173 | 56 | 164 | 52 |
| Jul | 88 | 461 | 21 | 88 | 463 | 173 | 54 | 153 | 52 |
| Aug | 92 | 447 | 21 | 93 | 472 | 177 | 52 | 147 | 52 |
| Sep | 94 | 441 | 21 | 98 | 475 | 176 | 52 | 144 | 51 |

* = Skill level 7 and above
** = Skill level 5 and below
*** = Civilian

Table 1 (Continued)

4. Average number of maintenance personnel assigned during FY 77:

   A. OMS

      1. Skill level 7 and above - 92
      2. Skill level 5 and below - 443
      3. Civilian - 21

   B. FMS

      1. Skill level 7 and above - 94
      2. Skill level 5 and below - 464
      3. Civilian - 173

   C. AMS

      1. Skill level 7 and above - 57
      2. Skill level 5 and below - 166
      3. Civilian - 52

   D. Average total number of maintenance personnel assigned during FY 77:

      1. Skill level 7 and above - 243
      2. Skill level 5 and below - 1073
      3. Civilian - 246

5. Average number of direct labor personnel assigned during FY 77:[3]

   1319

6. Average number of military direct labor personnel assigned during FY 77:

   1073

7. Percentage of military direct labor personnel versus total military personnel (1073 divided by 4891):

   22%

[1]Data collected from the Average Strength Report (October 1976 through September 1977) from Charleston AFB, South Carolina (11).

[2]Data collected from the Maintenance Digest, RCS: MAC-LGX (M) 7103 (October 1976 through September 1977) from Charleston AFB, South Carolina (13).

[3]Direct labor personnel (military and civilian).

Table 2 presents the same rationale with respect to Pope AFB, North Carolina. The Average Strength Data Reports for the first three months of FY 77 were unavailable from Pope AFB. Therefore, the first three months of Average Strength Data Reports for FY 78 were substituted in their place. Since the data were averaged over the entire year, this approach should not significantly affect the results of the data.

## DETERMINATION OF NUMBER OF AVAILABLE MANHOURS PER YEAR

Military personnel are paid the same amount whether or not they are working, sick, or on leave during the year. Based on this criterion the available manhours for the year include all time during the year except weekends and holidays. A total of 104 days for weekends and seven holidays were subtracted from 365 days in the year to determine the number of work days in the year. This left 254 working days during the year.

The work day was considered to be 8 hours to facilitate the comparison in the civilian industry as well as the military standard work day. The total number of hours available for labor in this report is the number of hours available per day times the number of days available for work during the year. The manhours available total is the number of direct labor personnel times the number of hours available. The results are presented in Table 3.

Table 2

Development of Percentage Factor for
Pope AFB, North Carolina

1. Number of military personnel assigned to Pope AFB, North Carolina during CY 77:[1]

| | Officer | Enlisted |
|---|---|---|
| January | 757 | 3514 |
| February | 679 | 3676 |
| March | 793 | 3667 |
| April | 756 | 3615 |
| May | 761 | 3707 |
| June | 727 | 3569 |
| July | 641 | 3330 |
| August | 637 | 3301 |
| September | 677 | 3340 |
| October | 706 | 3532 |
| November | 722 | 3502 |
| December | 658 | 3333 |

2. Average number of military personnel assigned during CY 77:

4224

3. Number of personnel assigned to maintenance activities during FY 77 by squadron:[2]

| | OMS | | | FMS | | | AMS | | |
|---|---|---|---|---|---|---|---|---|---|
| | A* | B** | C*** | A* | B** | C*** | A* | B** | C*** |
| Oct | 122 | 295 | 8 | 121 | 317 | 5 | 56 | 145 | 0 |
| Nov | 124 | 298 | 9 | 116 | 314 | 5 | 55 | 153 | 1 |
| Dec | 120 | 298 | 9 | 115 | 307 | 5 | 55 | 150 | 1 |
| Jan | 115 | 301 | 9 | 112 | 307 | 6 | 53 | 150 | 1 |
| Feb | 116 | 302 | 9 | 112 | 315 | 6 | 51 | 154 | 2 |
| Mar | 101 | 264 | 9 | 109 | 320 | 6 | 50 | 152 | 2 |
| Apr | 114 | 289 | 9 | 108 | 328 | 6 | 54 | 154 | 2 |
| May | 112 | 288 | 9 | 109 | 341 | 6 | 52 | 154 | 2 |
| Jun | 113 | 289 | 9 | 104 | 348 | 6 | 51 | 161 | 2 |
| Jul | 110 | 289 | 9 | 103 | 370 | 6 | 47 | 156 | 2 |
| Aug | 113 | 273 | 9 | 106 | 370 | 6 | 45 | 143 | 2 |
| Sep | 111 | 281 | 9 | 108 | 363 | 6 | 44 | 138 | 2 |

* = Skill level 7 and above
** = Skill level 5 and below
*** = Civilian

Table 2 (Continued)

4. Average number of maintenance personnel assigned during FY 77:

   A. OMS

      1. Skill level of 7 and above - 114
      2. Skill level of 5 and below - 288
      3. Civilian - 9

   B. FMS

      1. Skill level of 7 and above - 110
      2. Skill level of 5 and below - 333
      3. Civilian - 6

   C. AMS

      1. Skill level of 7 and above - 51
      2. Skill level of 5 and below - 151
      3. Civilian - 2

   D. Average total number of maintenance personnel assigned during FY 77:

      1. Skill level of 7 and above - 275
      2. Skill level of 5 and below - 772
      3. Civilian - 17

5. Average number of direct labor personnel assigned during FY 77:[3]

   789

6. Average number of military direct labor personnel assigned during FY 77:

   772

7. Percentage of military direct labor personnel versus total military personnel (772 divided by 4224):

   18%

[1]Data collected from the Average Strength Report (January 1977 through December 1977) from Pope AFB, North Carolina (12).

[2]Data collected from the Maintenance Digest RCS: MAC-LGX (M) 7103 (October 1976 through September 1977) from Pope AFB, North Carolina (14).

[3]Direct labor personnel (military and civilian).

Table 3

Number of Manhours Available During the Year

| | | | |
|---|---|---|---|
| 1. | Number of days available during the year | | |
| | A. | Number of days in the year | 365 |
| | B. | Less the number of days during the weekends | 104 |
| | C. | Less holidays | 7 |
| | D. | Total available days | 254 |
| 2. | Total number of hours available during the year | | |
| | A. | Number of days available | 254 |
| | B. | Number of hours available per day | 8 |
| | C. | Total number of hours available per year | 2032 |
| 3. | Total number of manhours available | | |
| | A. | Number of work hours available per year | 2032 |
| | B. | Number of direct labor personnel available | |
| | | 1. Charleston AFB, South Carolina | |
| | | a. Military | 1073 |
| | | b. Civilian | 246 |
| | | c. Total | 1319 |
| | | 2. Pope AFB, North Carolina | |
| | | a. Military | 773 |
| | | b. Civilian | 16 |
| | | c. Total | 789 |
| | C. | Total manhours available during the year | |
| | | 1. Charleston AFB, South Carolina | 2,680,208 |
| | | 2. Pope AFB, North Carolina | 1,603,248 |

## DIRECT COST OF MAINTENANCE LABOR

Direct cost of labor is incurred by the Air Force as an exclusive result of direct maintenance labor. The Accounting and Production Handbook provides a clear definition of direct labor. "Direct labor is that labor which benefits only the job order for which it is performed [21:320-2]." The same definition applies to the term "hands-on" maintenance. This labor is performed by the personnel who actually do the maintenance work. For this study, the personnel with skill levels five and below will be considered as direct labor personnel and their associated costs considered as direct labor costs.

In order to obtain the direct labor costs, the costs of supervisory personnel will be subtracted from the total cost of enlisted personnel listed on the Responsibility Center Manager Monthly Report and the Responsibility Center Manager Cost Center Report. The reports utilized are the 30 September 77 reports, which contain the total cost of military personnel for each of the maintenance squadrons.

For this study, all enlisted personnel with a skill level of seven or above will be considered supervisory personnel. Since the total cost of enlisted personnel is included in the full cost of labor, it does not matter how much is allocated to direct or supervisory labor.

Therefore, an arbitrary sum of $15,000 per man will be allocated to supervisory personnel. The annual salary of a married master sergeant with 14 years of service approximates this sum of $15,000. This will simplify the computations of the direct, indirect, and overhead costs.

The main utilization of civilian labor is in the Field Maintenance Squadron. A majority of these personnel are used in "hands-on" labor. Since the data used for this thesis do not subdivide these personnel into supervisory and direct labor categories, all civilian maintenance personnel will be considered direct labor personnel and their associated costs considered direct labor costs. However, the number of civilian personnel considered under the direct labor category will not be added to the number of military personnel assigned to the direct labor category for determining the indirect cost factor. The indirect cost of supporting direct labor personnel is associated with expense items dealing only with military personnel; so as a result, the number of civilian personnel were excluded. Table 4 presents the direct labor costs of Charleston AFB, South Carolina and Table 5 presents direct labor costs associated with Pope AFB, North Carolina.

Table 4

Direct Labor Cost at Charleston AFB, South Carolina

| | |
|---|---|
| 1. Cost of direct labor for each squadron | |
| A. Organizational Maintenance Squadron | |
| 1. Enlisted personnel (18:55) | $ 4,831,339 |
| 2. Civilian personnel (18:55) | $ 27,532 |
| 3. Less supervisory[1] (Table 1) | $ 1,380,000 |
| 4. Subtotal | $ 3,478,871 |
| B. Field Maintenance Squadron | |
| 1. Enlisted personnel (18:58) | $ 5,413,322 |
| 2. Civilian personnel (18:58,59) | $ 3,175,275 |
| 3. Less supervisory (Table 1) | $ 1,410,000 |
| 4. Subtotal | $ 7,178,597 |
| C. Avionics Maintenance Squadron | |
| 1. Enlisted personnel (18:64) | $ 2,155,510 |
| 2. Civilian personnel (18:64,65) | $ 986,971 |
| 3. Less supervisory (Table 1) | $ 855,000 |
| 4. Subtotal | $ 2,287,481 |
| 2. Total direct labor costs | $12,944,949 |

[1]Supervisory costs determined by multiplying the number of supervisors by $15,000. Supervisory personnel numbers presented on Table 1.

Table 5

Direct Labor Cost at Pope AFB, North Carolina

| | | |
|---|---|---|
| 1. | Cost of direct labor for each squadron | |
| | A. Organizational Maintenance Squadron | |
| | 1. Enlisted personnel (17:53,56) | $3,276,107 |
| | 2. Less supervisory[1] (Table 2) | $1,710,000 |
| | 3. Subtotal | $1,566,107 |
| | B. Field Maintenance Squadron | |
| | 1. Enlisted personnel (17:57,59,60, 61,62) | $4,106,148 |
| | 2. Civilian personnel (17:59,61) | $ 78,019 |
| | 3. Less supervisory (Table 2) | $1,650,000 |
| | 4. Subtotal | $2,534,167 |
| | C. Avionics Maintenance Squadron | |
| | 1. Enlisted personnel (17:63) | $1,778,770 |
| | 2. Less supervisory (Table 2) | $ 765,000 |
| | 3. Subtotal | $1,013,770 |
| 2. | Cost of central maintenance direct labor (17:124,125,126) | $1,028,588 |
| 3. | Total direct labor costs | $6,142,632 |

[1]Supervisory costs determined by multiplying the number of supervisors by $15,000. Supervisory personnel numbers presented on Table 2.

## INDIRECT COST OF MAINTENANCE LABOR

According to Anthony and Herzlinger, the cost of wages and salaries paid to employees is not the true cost of personnel. The added costs of taxes, fringe benefits, and other elements of compensation can easily amount to 25 percent or more of wages or salaries (1:124). These costs are classified as indirect costs. Indirect costs of labor include those elements of costs incurred as a result of support provided by base functional organizations. Anthony and Herzlinger further state: "Indirect costs are costs applicable to several cost objectives, one of which is the cost objective in question [1:122]."

The Accounting and Production Reporting Handbook defines indirect cost as "any cost not directly identified with a single final cost objective, but identified with two or more final cost objectives . . . [21:C-4]." The handbook goes on to state that indirect costs will be allocated to the benefiting direct cost centers by use of a base which will result in a cost which is in proportion to the benefits received. The classification of operational overhead costs in the handbook is the same as indirect cost defined in this thesis.

For this study, the functional organizations which support the direct labor personnel were included in compiling indirect costs. The total cost of the functional

organizations were multiplied by the percentage factor. This resulted in the proportion of total cost being allocated to indirect costs. Tables 6 and 7 present the indirect costs of the two bases involved in the study.

Base Headquarters Support

This element of cost is incurred by direct labor personnel because of the support provided. Some examples of support provided by base headquarters are: Judge Advocate, Chaplain, postal and courier, educational services, base photo laboratory, security police, military personnel, golf, bowling, recreation center, base exchange, and commissary.

Civil Engineer

This element of cost is incurred by direct labor personnel for fire protection, utilities, and maintenance of buildings and grounds, housing offices, referral office, golf course maintenance, and refuse collection and disposal.

Medical Services

This element of cost is incurred by direct labor personnel for the medical and dental support. These services are included in indirect cost because the personnel are not charged for their use. Alcohol abuse treatment is also provided under medical services.

Table 6

Allocated Indirect Cost

| | | |
|---|---|---|
| 1. | Charleston AFB, South Carolina | |
| | a. Base headquarters support (18:97) | $ 5,477,562 |
| | b. Civil engineering (18:112) | $ 9,644,727 |
| | c. Medical services (18:127) | $ 2,546,738 |
| | d. Total indirect costs | $17,669,027 |
| | e. Percentage factor (Table 1) | 22% |
| | f. Allocated indirect cost | $ 3,887,186 |
| 2. | Pope AFB, North Carolina | |
| | a. Base headquarters support (17:79, 83,99) | $ 5,762,439 |
| | b. Civil engineering (17:97) | $ 7,566,919 |
| | c. Medical services (17:106) | $ 1,487,020 |
| | d. Total indirect costs | $14,816,378 |
| | e. Percentage factor (Table 2) | 18% |
| | f. Allocated indirect cost | $ 2,666,948 |

Table 7

Total Indirect Cost

| | | |
|---|---|---|
| 1. | Charleston AFB, South Carolina | |
| | A. Organizational Maintenance Squadron | |
| | 1. Officer personnel (18:55) | $ 175,523 |
| | 2. Supervisory personnel (Table 4) | $1,380,000 |
| | 3. Subtotal | $1,555,523 |
| | B. Field Maintenance Squadron | |
| | 1. Officer personnel (18:58) | $ 100,192 |
| | 2. Supervisory personnel (Table 4) | $1,410,000 |
| | 3. Subtotal | $1,510,192 |
| | C. Avionics Maintenance Squadron | |
| | 1. Officer personnel (18:64) | $ 87,045 |
| | 2. Supervisory personnel (Table 4) | $ 855,000 |
| | 3. Subtotal | $ 942,045 |
| | D. Allocated indirect cost (Table 6) | $3,887,186 |
| | E. Total indirect cost | $7,894,946 |
| 2. | Pope AFB, North Carolina | |
| | A. Organizational Maintenance Squadron | |
| | 1. Officer personnel (17:53) | $ 109,203 |
| | 2. Supervisory personnel (Table 5) | $1,710,000 |
| | 3. Subtotal | $1,928,406 |
| | B. Field Maintenance Squadron | |
| | 1. Officer personnel (17:57,59) | $ 78,170 |
| | 2. Supervisory personnel (Table 5) | $1,650,000 |
| | 3. Subtotal | $1,728,170 |
| | C. Avionics Maintenance Squadron | |
| | 1. Officer personnel (17:63) | $ 50,604 |
| | 2. Supervisory personnel (Table 5) | $ 765,000 |
| | 3. Subtotal | $ 815,604 |
| | D. Central Maintenance | |
| | 1. Officer personnel (17:126) | $ 88,443 |
| | E. Allocated indirect cost (Table 6) | $2,666,948 |
| | F. Total indirect cost | $7,227,571 |

## OVERHEAD COST OF MAINTENANCE LABOR

Overhead costs are those costs which are incurred by the organization performing the activity. The Accounting and Production Reporting Handbook defines this as shop expense or operations overhead. Shop expense consists of indirect labor and indirect material costs that are proper charges to a productive responsibility center but cannot be practically or economically identified to a specific job (21:pp.350-1).

The costs of the chief of maintenance function and the maintenance operational costs will be included as overhead expenses for this study. Table 8 presents the overhead costs for Charleston AFB, South Carolina and Pope AFB, North Carolina.

## COMPUTED BASE LABOR RATE

As previously stated, the full cost of maintenance labor is the summation of direct labor, indirect labor, and overhead costs. The full cost of maintenance labor divided by the number of maintenance manhours available will give the cost of maintenance as an hourly rate. Table 9 presents the computations for the maintenance hourly rate for the two bases in question.

Table 8

Overhead Cost

| | | |
|---|---|---|
| 1. | Charleston AFB, South Carolina | |
| | a. Organizational Maintenance Squadron (18:57) | $ 2,244,003 |
| | b. Field Maintenance Squadron (18:63) | $ 5,469,751 |
| | c. Avionics Maintenance Squadron (18:68) | $ 1,398,588 |
| | d. Chief of Maintenance (18:54) | $ 2,925,364 |
| | e. Total Overhead Cost | $12,037,706 |
| 2. | Pope AFB, North Carolina | |
| | a. Organizational Maintenance Squadron (17:53,54) | $ 1,029,785 |
| | b. Field Maintenance Squadron (17:58,59,60,71,62) | $ 1,824,952 |
| | c. Avionics Maintenance Squadron (17:63,64,65,66,67) | $ 987,453 |
| | d. Chief of Maintenance (17:52) | $ 2,073,595 |
| | e. Central Maintenance (17:127) | $ 4,105 |
| | f. Total Overhead Cost | $ 5,919,890 |

Table 9

Base Labor Rate

| | | |
|---|---|---|
| 1. | Charleston AFB, South Carolina | |
| | a. Direct Costs (Table 4) | $12,944,949 |
| | b. Indirect Costs (Table 7) | $ 7,894,949 |
| | c. Overhead Costs (Table 8) | $12,037,706 |
| | d. Total Labor Costs | $32,877,601 |
| | e. Total Manhours Available (Table 3) | 2,680,208 |
| | f. Base Labor Rate | $12.27 |
| 2. | Pope AFB, North Carolina | |
| | a. Direct Costs (Table 5) | $ 6,142,632 |
| | b. Indirect Costs (Table 7) | $ 7,227,571 |
| | c. Overhead Costs (Table 8) | $ 5,919,890 |
| | d. Total Labor Costs | $19,290,093 |
| | e. Total Manhours Available (Table 3) | 1,603,248 |
| | f. Base Labor Rate | $12.03 |

## OMITTED ELEMENTS OF COST

Certain elements of costs, which should be included in a full costing approach, had to be omitted due to the lack of data. This lack of data is partially caused by the different funding utilized by the Air Force. Certain operations or services are industrially funded and others funded by Operations and Maintenance appropriations. This different funding makes it difficult to insure all costs are considered and correctly put into the cost elements.

The specific items which the authors were unable to put into the full cost calculation were: retirement, acquisition, training, and permanent change of station. Although these elements of cost were not considered in this thesis, a standard factor, such as those contained in AFR 173-10, USAF Cost and Planning Factors, might be utilized to incorporate them into the cost models to obtain the full cost of maintenance labor.

# Chapter 4

# MAINTENANCE COST SYSTEM

## OVERVIEW

The base level maintenance cost system (MCS) is designed to accumulate cost data for aircraft maintenance organizations. The objectives of the MCS are: to accumulate cost of organizational and intermediate level maintenance activities, provide data for life cycle costing, and to provide cost of total maintenance labor expenditures by direct, indirect, and overhead categories. The Air Force uses the B 3500 computer to interface the Maintenance Data Collection System (MDCS), Maintenance Management Information and Control System and the general accounting system to compile and compute the output of the MCS (20:pp.2-1, 2-2).

The purpose of the MCS is to provide to the various levels of maintenance management comparative cost data by weapon system. The system identifies the cost of the resources required to support the maintenance function (20:pp.2-10). The resources are categorized as direct, indirect, and overhead costs.

## ELEMENTS OF COST

### Direct Cost

Direct costs are those costs which can be identified to the end item upon which maintenance is performed (20:pp.2-11). The specific elements which are included in direct cost are direct labor (civilian, military, and contractor) and direct material. Direct labor is defined as "the touch" or "hands-on" labor of personnel actually performing the work. Civilian labor hours are received from the MDCS and are costed by application of an average hourly rate for each grade. Military labor hours are also received from the MDCS and are costed by application of an hourly labor rate based on grade and the composite standard rate table in AFM 177-101, paragraph 50525. Contract maintenance costs are based upon the contract. Direct material is either funded or unfunded. Funded material is actually used in production and unfunded is the cost to repair investment items to AFLC. The specific elements when summed together make up direct costs (20:pp.3-66,67).

### Indirect Cost

Indirect costs are those which are not readily identifiable with the end products but identifiable with the production effort. The MCS classifies the costs of supervision (civilian and military), training, detail, leave, compensatory time, alert, plus other miscellaneous

expenses identifiable to the production activity. Also included are local purchase items, benchstocks, and fuel required for ground operations.

The hours required by direct labor personnel in the different categories are extracted from the MDCS and multiplied by the applicable rates (civilian and military). The individual costs are then summed to determine the total indirect costs (20:pp.3-69).

Overhead Cost

Overhead expenses are those which are identifiable to the General and Administrative function of maintenance as opposed to the shop function. This type of cost includes all of the labor, materials, and other overhead costs incurred in support of the maintenance activity. Costs included as overhead are costs of rents, TDY, contractual services, purchased utilities, communications, printing, and reproduction. The total overhead costs are determined when the specific costs are summed (20:pp.3-67).

## REPORTS

The MCS output includes numerous reports. Some reports are by Workload Breakdown Structure (WBS) within Mission/Design/Series (MDS) within Program Element Code (PEC), Work Accomplishment Code (WAC) within MDS within PEC, indirect labor category, and by overhead category.

These reports provide the chief of maintenance and his staff cost data for analysis, isolation, and control of the cost of resources consumed in the maintenance operation (20:pp.3-66). The reports are cost orientated, meaning costs are measured by consumption rather than by assignment of resources or obligation of funds.

The MCS also provides reports to higher management levels. The MAJCOM Maintenance Cost System receives, processes, and consolidates base-submitted MCS report data. These data are combined with command level input and data from other MAJCOM's to create the MCS data base. This data base is the source for command consolidated reports and cost information needed by MAJCOM staff agencies and higher levels of management.

## COMPARISON OF DATA

The Organizational and Intermediate Maintenance Cost Report--WBS within MDS within PEC (Report 1A) was used to compare the findings of the full cost approach at the selected bases to the output of the MCS. The MCS report was modified to discount the cost of material. The total cost was divided by the number of direct labor hours to determine a labor rate. Table 10 presents the data for the two bases.

Table 10

MCS Labor Rate

| | | |
|---|---|---|
| 1. | Charleston AFB, South Carolina (FY 77) | |
| | a. Total Cost of Maintenance Function (15:11) | $27,022,231 |
| | b. Less Material Cost (15:11) | $ 1,880,919 |
| | c. Total Cost Less Material Cost | $25,141,312 |
| | d. Number of Hours of Direct Labor (15:11) | 1,954,993 |
| | e. Labor Rate | $12.86 |
| 2. | Pope AFB, North Carolina | |
| | a. Total Cost of Maintenance Function (16:1) | $16,465,164 |
| | b. Less Material Cost (16:1) | $ 689,312 |
| | c. Total Cost Less Material Cost | $15,775,852 |
| | d. Number of Hours of Direct Labor (16:1) | 1,599,741 |
| | e. Labor Rate | $9.86 |

# Chapter 5

# CONCLUSIONS AND RECOMMENDATIONS

## OVERVIEW

The purpose of this research was to make a cost analysis of the full cost of performing aircraft maintenance at the base level. Elements of cost were identified and the monetary value of each element was determined. The hours available to perform maintenance were determined and divided into the full cost of maintenance to derive an hourly rate. This hourly rate was compared to the hourly rate derived by the Maintenance Cost System. In this chapter the conclusions and implications of the cost analysis are presented and recommendations for use of the results are made.

## CONCLUSIONS

### Full Cost Results

Based on the data presented in Chapter 3, the full cost of maintenance at the base level reduced to an hourly rate was $12.27 for Charleston AFB, South Carolina and $12.03 for Pope AFB, North Carolina. However, it must be noted that some elements of cost were omitted in the calculation of the BLR. Specifically, the costs of

retirement, military personnel acquisition and training, and permanent change of station. If these costs were included in the computation, then the hourly maintenance labor rate would have been greater. Anthony and Herzlinger note that these additional elements of cost can easily amount to 25 percent or more of the wages paid to employees (1:124). Using the personnel data contained in Tables 4, 5, and 7 coupled with the personnel support and pipeline cost formulae contained in AFR 173-10, the authors determined that acquisition, training, and PCS costs amounted to 14.46% of the annual wages and salaries (19:A-153). Hayes and Williamson determined that Air Force retirement benefits cost the Air Force an additional 17 percent of annual wage costs (5:67). Therefore, the costs of retirement personnel acquisition and training, and PCS costs could add an additional 31 percent to the annual maintenance personnel labor costs at Pope and Charleston Air Force Bases.

MCS Results

The MCS data, adjusted for material costs, led to the calculation of an hourly cost of maintenance labor of $12.86 at Charleston AFB, South Carolina and $9.86 at Pope AFB, North Carolina. Again it must be noted that some elements of cost were excluded from the data utilized by this system. Specifically, the same elements of cost

which were omitted from the full cost calculations were also omitted by the Maintenance Cost System.

Comparison of Results

The two labor rates determined for Charleston AFB, South Carolina are reasonably similar. The actual difference between the MCS calculation and the full cost calculation is $.59.

If the total manhours available during the year for Charleston AFB are used to compute the total difference in cost, the difference amounts to $1,581,323. This is 4.8 percent of the total labor expenditure of $32,877,601. Therefore, the hourly labor rate derived from the MCS seems to closely approximate the hourly rate derived from the full cost approach.

However, the results do not appear to be as similar at Pope AFB, North Carolina. The difference between the two maintenance labor hourly rates at Pope AFB, North Carolina is much greater than the difference between the labor rates at Charleston AFB, South Carolina. The difference between the MCS calculation and the full cost calculation is $2.17. If total manhours available during the year at Pope AFB are used to compute the total difference in cost, the difference amounts to $3,479,048. This is 18 percent of the total expenditures for labor of $19,290,093. Therefore, the hourly rate derived from the

MCS does not approximate the hourly rate derived from the full cost approach.

Since the cost data base and methodology were the same for the two bases, the authors can only surmise why the full cost BLR closely approximated the MCS Base Labor Rate at Charleston AFB, South Carolina and failed at Pope AFB, North Carolina. The main difference between the two bases is the type of mission. Charleston AFB supports the C-141 weapon system which has a strategic airlift mission. The cost of this mission is industrially funded and the users pay for the services rendered. On the other hand, Pope AFB supports the C-130 weapon system which has a tactical airlift mission. The cost of this mission is funded by Operations and Maintenance (O&M) and by industrial funds. The O&M costs are those costs which the tactical airlift mission of MAC requires to support its own internal operations, while the industrial fund costs are those incurred by the users outside MAC who request airlift support. The overlapping of accounting requirements may be one of the reasons why the full cost BLR at Pope AFB was higher than the BLR determined by the MCS.

The mission of TAC requires that mobility be one of TAC's primary operational characteristics. This mobility requirement necessitates TAC bases being organized to support the mission while in the field. As a result, an increased number of maintenance personnel with higher skill

levels and more experience are required. The ratio of supervisory personnel to the total number of maintenance personnel was significantly greater at Pope AFB than at Charleston AFB. The wages of these personnel are higher since they are personnel with higher rank and greater length of service. This again may have influenced why the full cost BLR at Pope AFB was greater than the BLR determined by the MCS.

The final reason which may have caused the difference between the two labor rates is the utilization of labor personnel. Charleston AFB, which is part of the Military Airlift Command (MAC), is manned to support a wartime surge condition. Therefore, the utilization of personnel during peacetime is low. This causes the hourly rate to be less since more manhours are available than are being used. This is not the case at Pope AFB, which was still being manned under the Tactical Air Command Unit Detail Listing (manning authorization document) at the time these data were gathered. Pope AFB was manned to perform the assigned mission including deployment requirements but without a formal wartime surge being included. This resulted in a higher utilization rate of personnel. The labor rate will be higher when the utilization rate is greater since the number of productive manhours closely approximates the number of available manhours.

As stated previously, these are some of the reasons the authors felt might explain the difference between the labor rate computed by the full cost approach and the labor rate determined by the MCS. There may be other reasons which were not apparent to the authors.

Limitations

There are many limitations in this thesis. First, the study was limited to bases which support transport type aircraft. Results from this study may not be appropriate for other types of weapon systems. Second, both bases were geographically located in the Southeastern United States. This may not be representative of other geographical areas in the United States. Third, the research was limited in scope due to time. For a more comprehensive study, more bases which support different type of weapon systems in different geographical locations should be included to gain a better representative sample of maintenance labor rates. Fourth, the monetary value for military personnel costs contained in the Responsibility Center Managers Reports is based upon standard rates according to grade and time in service. The pay and allowances for each military person varies according to whether the person is married, lives on base, or is on separate rations. The actual cost of each person was not feasible to calculate due to the many different variables and due

to the limited accessibility of data by the Privacy Act. Finally, not all cost data required for the full cost approach are contained in reports obtainable at the base level. This last limitation is also a problem which is discussed below.

Problems

The full cost approach requires that all costs which are relevant to the cost objective be included. The elements of cost which were not included in the full cost of labor were: retirement, acquisition of personnel, training of personnel, and permanent change of station. The reason these costs were not available for inclusion is because of the way in which the military funds its operations and programs. For example, the costs of training personnel in maintenance skills is funded by Air Training Command. The cost of training is not charged to the organization which benefits from this training. Therefore, the training element of cost is not included in the full cost of maintenance labor.

The problem of funding is also relevant to the base operations. Some of the funding is done by Operations and Maintenance (O&M) and other is accomplished by Industrial funding. The two fundings can apply to different segments of the same operation. Therefore, it is necessary to determine if one or both fundings apply and include them in the cost elements.

Findings

Although the maintenance labor rates for Charleston AFB, South Carolina were relatively close, the deduction that the full cost approach produces similar results as the MCS cannot be made since the maintenance labor rates at Pope AFB, North Carolina were so different. Therefore, the findings of this research are inconclusive as to whether the full cost of maintenance labor reduced to an hourly rate approximates the hourly rate determined by the MCS.

Further, the full cost approach to determine maintenance labor rates at the base level is not feasible unless standard factors are utilized to compensate for the missing elements of cost.

## RECOMMENDATIONS

Based on the results of this study, the authors recommend that an indepth study be made to validate the Maintenance Cost System. If further study determines that the MCS reasonably approximates the cost of performing maintenance at the base level, then it will be an efficient way to determine labor rates for cost models. If not, then the study may promote further research on how to accomplish this objective.

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